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January 30, 2017

Arthur Burbank
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**Subject: Smoky Canyon Mine Remedial Investigation/Feasibility Study (RI/FS)
Simplot Responses to Agency Comments on
Draft Phase 2 Pilot Study Work Plan and Sampling and Analysis Plan
Ultra-Filtration/Reverse Osmosis and Biological Selenium Removal Fluidized Bed
Bioreactor Treatment Technology**

Dear Art,

Enclosed for your review are the response to the Agency comments (January 3 and 13, 2017) on the *Draft Phase 2 Pilot Study Work Plan and Sampling and Analysis Plan, Ultra-Filtration/Reverse Osmosis and Biological Selenium Removal Fluidized Bed Bioreactor Treatment Technology*. Included with the responses are revised Tables 3-8 and 4-1. Table 4-1 (Benchmarks for Surface Water) was updated to address one of the Agency comments and to also include information presented in the Smoky Canyon Mine RI/FS *Final Site-Specific Ecological Risk Assessment Report* (December 2015) and other sources.

Please contact me if you have any questions or comments on this submittal.

Sincerely,


Jeffrey Hamilton
Environmental Engineer

Enclosures

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**Simplot Responses to Agency Comments (January 3, 2017) and
Additional Comments (January 13, 2017) on the
“Draft Phase 2 Pilot Study Work Plan and Sampling and Analysis Plan
Ultra-Filtration/Reverse Osmosis and Biological Selenium Removal Fluidized Bed
Bioreactor Treatment Technology” (October 2016)**

Specific Comments (January 3, 2017):

SC-1 Section 1.1, Page 3, Purpose and Objectives of the Pilot Study, second paragraph.

Figure 1-2 and the corresponding text are a little confusing and need clarification. The text states that UF permeate flow to RO is 2000 gallons per minute (gpm); is the 100 gpm flow from UF to outfall concentrate or backwash (should this be stated)? Also, the text states that RO concentrate flow to FBR is 500 gpm; the figure should state that the 1500 gpm flow from RO to outfall is permeate. Figure 1-2 is inconsistent in how it depicts different flow streams exiting the unit processes: the flow going forward (right) from UF to RO is permeate, whereas the flow going forward from RO to FBR is concentrate (permeate goes up to outfall). Please revise the figure to be consistent or label (or otherwise differentiate) the streams.

Response: The UF system does not generate concentrate. The 100 gpm flow from UF to outfall is backwash. Flow from RO system is 500 gpm concentrate to FBR system, and 1500 gpm permeate to effluent blend tank. The text has been modified to:

“Design flows for the Phase 2 Pilot Study system include (Figure 1-2) a feed flow of approximately 2,100 gpm to the UF system from which approximately 100 gpm of backwash will go to the effluent blend tank and then to the effluent stream and 2,000 gpm of permeate to the RO system. From the RO system, 1,500 gpm of permeate will be discharged to the effluent blend tank and then will be discharged to the effluent stream, and the other 500 gpm of concentrate will go to the FBR units, followed by post-treatment with subsequent discharge to the effluent stream.”

As requested, additional information has been added to the process flow diagram (Figure 1-2).

SC-2 Section 2.1.1, Page 6, paragraph below Figure 2-1. Please describe what is meant by “drain”.

Response: The text has been revised to refer to the “spring collection location” instead of “drain”.

SC-3 Section 2.1.1, Page 7, first paragraph below Figure 2-2. No reference to Figure 2-3 was found. The middle of the first sentence in this paragraph (before the word “and”) seems the proper place to cite it.

Response: As suggested, a citation for Figure 2-3 has been added to the text.

- SC-4 Figure 2-3, Page 8.** *This figure needs to be clarified – there are 3 "red" lines in the legend and 2 "red" lines on the plot. The line starting at the middle of 2007 does not appear to be represented in the legend; there is only 1 line that ends in 2009, and no line is shown that starts in 2009. Additionally, the very slight difference in shading is difficult to discern.*

Matt
EPA

Response: The lines in Figure 2-3 have been updated to clearly depict LSS-SP-N3 and LSS-SP-N4 between 2007 and 2009, and the combined LSS-SP-N from 2009 to present.

- SC-5 Section 2.2, Page 10, Pilot System Considerations, second paragraph.** *In fourth sentence, please specify or describe RO streams to distinguish them from UF streams – i.e., "...discharging RO permeate and feeding RO concentrate to the FBR..."*

Response: The text has been revised as requested by this comment.

- SC -6 Section 2.3.1, Page 12, UF Technology Overview, first paragraph.** *The word "size" on line 4 appears to be a typo; it should be "side".*

Response: The word has been corrected as indicated by this comment.

- SC-7 Section 3.0, Page 15, Pilot Study design, Figure 3-1.** *See comments above in SC-1 on Figure 1-2 (which is the same as Figure 3-1). Please delete the 2nd copy of the diagram.*

Response: The diagram has been revised to depict the additional information requested. Figure 3-1 has been removed, and the text now refers back to Figure 1-2.

- SC- 8 Section 3.1.2, Page 16, South Fork Sage Creek Pump Station Description, first paragraph.** *Are the pipelines buried for freeze protection and to maintain temperature (to the degree practical)? Are the Hoopes Spring pipelines buried for freeze protection and to maintain temperature (to the degree practical) (Section 3.1.3). Have they already been utilized throughout one or more winters?*

Response: The piping leading to and from the treatment system has been operated through two winters and freezing has not been an issue.

*
just coz they
haven't
frozen
yet -
doesn't
mean
that
precautions
shouldn't
be taken

- SC-9 Section 3.1.6, Page 22, Ultra-Filtration System Description, Figure 3-6 and associated text.** *The text states that the 2-week CIP waste (after quenching and neutralization) is stored in the Neutralized CIP Rinse Waste Storage Tank and then metered to the activated sludge system. The text also says the 3-month membrane cleaning waste is stored in the CIP Chemical Waste Storage Tank and is ultimately hauled off-site. Figure 3-6 is ambiguous about these flows. Does the 2-week CIP waste*

goes to the Rinse Tank via the Waste Tank, as shown (this would pre-suppose that no 3-month cleaning waste is present)? Or, rather, should there be a separate arrow from the UF directly to the Rinse Tank? Other suggestions: for completeness, the schematic could show influent arrows for backwash supply water and CIP feed water from the RO Permeate Tank; the existing backwash box could be called dirty backwash for clarity. Please clarify.

Response: Figure 3-5 (formerly Figure 3-6) has been revised to better correlate with the text description of operations.

SC-10 Section 3.1.7, Page 23, RO System Description, Figure 3-7. Provide a double headed arrow between RO and Permeate tank to indicate backwash, in the figure.

Response: Figure 3-6 (formerly Figure 3-7) has been revised to reflect the process in additional detail.

SC-11 Section 3.1.8, Page 23, FBR System Description, first paragraph. If the FBR process is up flow and "backwashing" is also up flow, the term "backwashing" is a misnomer because it typically implies countercurrent flow. Please provide an explanation. Does backwashing consist of using a higher flow rate (and higher upward velocity) designed to flush out solids (e.g., precipitated Se, and possibly bio solids) while retaining the support media (GAC), or is a portion of the media flushed out as well (requiring either fresh make-up or cleaning and replacement)?

Response: The text has been modified to:

"A reducing environment will be created within a fluidized stage that concurrently expels gas and maintains optimum biofilm conditions for selenium reduction and retention. A second stage operating in downflow serves to filter the precipitated selenium and biomass. The FBR system generates biomass while precipitating the influent selenium. The first stage is periodically surged in flow and the second stage is periodically backwashed to transfer the biomass and precipitated solids to a backwash clarifier tank. The pumps that pull water from the FBRs and deliver it to the aeration tank can be operated in reverse to provide flow for the backwashing operations."

SC-12 Section 3.1.9, Page 25, Post-Treatment System Description, first paragraph. Are the activated sludge aeration tanks operated in series or parallel?

Response: Text has been added to clarify that the aeration tanks are operated in parallel.

SC-13 Section 3.1.9, Page 25, Post-Treatment System Description, second paragraph. There is very little information of the continuously-backwashed sand filters – such as maker, sizing, location (in or outside of the building), etc. Also, since the filters are presented as part of the post-treatment system, it would make more sense to say that

the sand filter backwash is pumped back to the aeration tanks, rather than to the post-treatment system as currently stated. Please clarify.

Response: The text has been modified to:

"The aeration tank effluent flows by gravity to the gravity clarifier, where solids are settled and returned to the head of the aeration tanks, and the clarifier effluent is pumped to the continuously backwashed sand filters, where alum or ferric chloride are added, for removal of phosphorus and carryover biological solids from the clarifier. The sand filter filtrate flows by gravity to the outfall and the sand filter backwash is pumped back to the aeration tank where the solids can be settled in the clarifier."

SC-14 Section 3.1.9, Page 25, Post-Treatment System Description. *Has the potential for water freezing in the clarifier in winter been evaluated, and, if necessary, have provisions been made to mitigate this? It states that it will be covered (but presumably without heat); is that sufficient?*

Response: To limit the freezing potential of the clarifier, the tank is insulated and the clarifier is covered and provided in a unit heater. It is believed that the freeze protection provisions will be adequate to prevent freezing.

SC-15 Section 3.1.9, Page 26, Post-Treatment System Description, first paragraph and Figure 3-9. *Is the Sludge Storage tank used to hold activated sludge biosolids shown in Figure 3-9 the same tank as the Solids Storage Tank for FBR sludge shown in Figure 3-8? Would there be value in segregating the presumably "clean" WAS from the selenium-rich FBR solids, in case the latter exceeds the TCLP limit for Se and requires disposal as hazardous waste? Could the WAS be land-applied onsite, rather than being trucked offsite to a landfill?*

Response: The sludge disposal options are currently under evaluation. A Work Plan modification will be submitted if the planned operations are modified.

SC-16 Section 3.3, Page 27, Pilot Unit Operation, second paragraph. *Why use ammonium sulfate as N source? That would seem to exacerbate the potential for sulfate reducing metabolism and potential for generating sulfides/H₂S. Please explain.*

Response: Ammonium sulfate is the most rapidly bioavailable form of nitrogen which is a consideration due to the short hydraulic retention time through the system. The generation of H₂S has not been problematic during the Phase I operations.

SC-17 Section 3.3, Page 30, Pilot Unit Operation, first paragraph. *The text states FBRs will be operated to maintain ORP in the -200 to -500 mV range. This is well in the range where sulfate reduction/sulfide precipitation can occur. Is the treatment facility equipped with H₂S air monitors as a health and safety precaution?*

EPA

one assumes then personal monitor have alarm. Correct?

Response: Yes, the system is equipped with multiple H₂S air monitors and operators wear personal monitors when working in the areas around the FBRs. The automated alarm and ventilation system is configured into the facility monitoring system.

SC-18 Section 3.3, Page 30, Pilot Unit Operation, first paragraph. While FBR treatment for Se has been gaining acceptance through observed effectiveness at various mining sites, there are some inherent challenges: 1) the potential release of particulate elemental Se in the treated water; 2) kinetics; 3) maintaining redox and pH conditions that are conducive to formation of elemental Se rather than soluble forms of Se; 4) maintaining the active, biological communities in the reactor; and 5) being able to mechanically keep the bed in a fluidized state. Therefore, Simplot should be cognizant of how well the process can maintain stability in upset conditions. *- EPA*

Post-treatment of effluent from a FBR generally includes aeration to remove biochemical oxygen demand (BOD) and any hydrogen sulfide that might have been produced, as well as addition of a flocculent to aid in settling out of microorganisms and particulates and a subsequent sand filtration step to remove particles. If particulate elemental Se is present in the effluent, there is the potential that particles will be reoxidized to selenite and/or selenate, both of which are soluble. In some studies, therefore, an additional filtration step conducted prior to aeration has been recommended to minimize this potential.

Selenium chemistry is redox sensitive and only the elemental form of Se is insoluble. A predominance diagram (Reference 1) is shown below for the stable Eh and pH zones for various inorganic Se species. Boundaries for predominance zones vary depending on temperature and concentration (or analyte activity). The diagram presented below is for a system at room temperature and a concentration of 1 μ M, which is similar to the average concentration (125 μ g/l = 1.58 μ M) of Se in the influent of the Phase 1 pilot.

The blue box represents the region captured by the influent pH range (6 to 9) and the stated desired ORP range of -200 to -500 mV (converted to Eh assuming a conversion factor of +200 mV – see next paragraph). The orange diagonal line is the boundary between elemental Se, which is insoluble, and hydrogen selenide [Se(II)], which is soluble. Although it may be re-oxidized to elemental Se in the post-FBR treatment step and be sequestered during flocculation, any HSe⁻ formed may travel through the post-treatment system in the dissolved phase to oxidize downstream. It is recommended that the Eh zone above the orange line be targeted for most effective removal of Se within the FBR system as elemental Se.

Eh is the redox potential normalized to the hydrogen electrode and is the value used for direct comparison to tabulated values in redox tables for reactions. The factor used to convert measured ORP vales to *Eh* vary depending on the filling solution of the particular probe used. The below table (Reference 2) provides values for several filling solutions and the conversion factors based on temperature. It is recommended that *Eh* values be reported alongside ORP values, or at least that temperature and the type of filling solution are provided for later calculation.

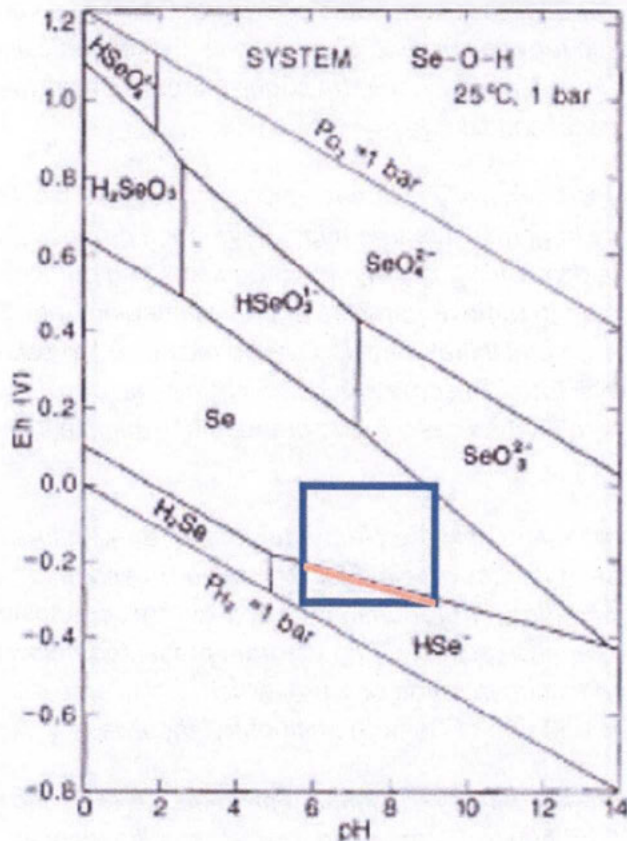


Fig. 4. Eh-pH diagram for part of the system Se-O-H.
The activity of dissolved Se = 10^{-4} . See text for discussion.

Half-cell Potential of Ag/AgCl reference electrode

derived from USGS NFM, Table 6.5.2 (9/2005)

T(°C)	Molarity of KCl filling solution			
	3M	3.3M*	3.5M	Sat/4M
10	220	217	215	214
15	216	214	212	209
20	213	210	208	204
25	209	207	205	199
30	205	203	201	194
35	202	199	197	189
40	198	195	193	184

*interpolated value

Response: Pourbaix diagrams are used as a guideline to define target ORP conditions in our system. As these are somewhat theoretical, and do not cover all water chemistry conditions encountered in the field, our approach is to correlate the actual ORP and pH of the effluent with removal efficiencies to achieve maximum removal.

A couple of points in regards to the bioreactor ORP: 1) the FBR operates similar to a plug flow reactor and is not well mixed, and (2) the ORP measurement is taken at the (bulk liquid) effluent from the second stage.

In order to ensure that throughout the entire depth of the second stage reactor operation takes place in the zone where oxidized species (selenate, selenite) are reduced to elemental selenium, we target the low end of the ORP range at the second stage effluent measurement point. This will ensure that we are in the conditions in which elemental selenium is the predominant equilibrium species throughout most of the bioreactor bed. The Work Plan/SAP cites an ORP range of -200 to -500mV to cover the entire span of operating pHs (6-9) that might be encountered during operations. During Phase 1, operation has been at a pH of approximately 7 and an effluent ORP slightly below -400 mV. This puts us at the target discharge ORP from the second stage as shown below on the Eh-pH diagram, for example.

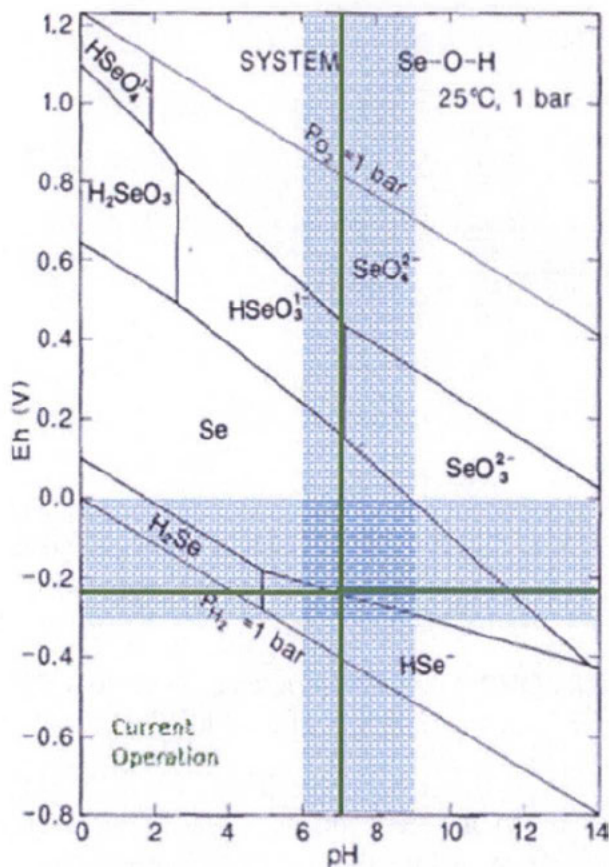


Fig. 4. Eh-pH diagram for part of the system Se-O-H. The activity of dissolved Se = 10^{-6} . See text for discussion

SC-19 Section 3.3, Page 30, Pilot Unit Operation, all four paragraphs. Please clarify which monitoring and O&M functions are automated and which are manual. [Note: some automated, continuously monitored parameters are identified under Section 3.3.2]. What are the expected operator labor requirements?

Response: The entire treatment system is run via automated controls which monitor tank levels, pumping rates, and equipment status. Water quality parameters which cannot be monitored with online sensors are sampled and analyzed in the onsite laboratory for operational monitoring, and others are sent to offsite laboratories for analysis which require a certified laboratory. Operators will be onsite as necessary to keep the system operating efficiently.

SC-20 Section 3.3, Page 30, Pilot Unit Operation, fourth paragraph. The phrase about the FBR biomass "...consuming and filtering the influent selenium..." is technically inaccurate: the microbial culture does not consume or filter Se. Please clarify.

Response: The text has been modified to:

"The FBRs will generate biomass while reducing influent selenium and filtering the reduced particulate selenium, and will require backwashing to the backwash clarifier."

SC-21 Section 3.3.2, Page 32, Pilot Unit Monitoring, Table 3-8. *It is strongly recommended that monitoring be performed at multiple locations within the system rather than just on the system influent and effluent as specified in Table 3-8. Monitoring a few key parameters at intermediate points would allow evaluation at different unit processes along the treatment train, in addition to the overall system. Given that Simplot is going to considerable expense to conduct this pilot study, it would be unfortunate not to collect the data needed to fully evaluate operation and performance of all the treatment processes involved (UF, RO, FBR, activated sludge bio treatment, clarification, sand filtration). Please include a discussion regarding anticipated monitoring on the system.*

Response: This Work Plan/SAP covers environmental monitoring, whereas operational monitoring as identified in this comment is performed outside of this Work Plan/SAP. Operational monitoring is implemented by the operator to track the effectiveness of all treatment system unit processes, and to provide data for adjusting and fine-tuning the system as the study progresses. The specific parameters which are monitored and frequency of monitoring depend upon the unit process. Parameters and frequencies for operational monitoring will change with time based on what is learned during the study.

Environmental monitoring, covered under this Work Plan/SAP, will involve collecting samples for chemical analysis by an off-site laboratory and documenting readings from in-line probes for field parameters including temperature, pH, ORP, DO, and others. This type of monitoring has been distinguished in the text, to clearly show that this Work Plan/SAP covers environmental monitoring and not operational monitoring. The following text has been added to Section 3.3.2 immediately after the second paragraph:

"Environmental monitoring, which is covered under this Work Plan/SAP, involves collecting samples for chemical analysis by an off-site laboratory and documenting readings from in-line probes for field parameters including temperature, pH, ORP, DO, and others. Operational monitoring is implemented by the operator to track the effectiveness of all treatment system unit processes, and to provide data for adjusting and fine-tuning the system as the study progresses. The specific parameters which are monitored and frequency of operational monitoring depend upon the unit process. Parameters and frequencies for operational monitoring will change with time based on what is learned during the study."

SC-22 Section 3.3.2, Page 32, Pilot Unit Monitoring, Table 3-8. *Please define Influent and Effluent. At first glance, these might mean FBR influent and effluent, since that is the primary Se removal process. From later context, it became clear that these are total*

system influent and effluent, where influent is raw water (UF influent) and effluent is either sand filter effluent or final system effluent after re-blending filter effluent with bypassed water (please clarify). Seems like monitoring at multiple locations (e.g., similar to those indicated in Table 3-8 for the one-time initial startup sample) on a regular basis throughout the study, would be warranted, to allow evaluation of the performance and operation adjustment/optimization/troubleshooting of the different unit processes in the treatment train. Selected key parameters pertinent to each unit process would be sufficient. For example, do you need to know FBR influent Se and FBR effluent Se, BOD, N, P, and sulfide (in addition to pH, DO, and ORP determined by inline meters) to help optimize operation and chemical feed rates? Another example is that it would be difficult to determine and adjust activated sludge SRT without knowing the solids concentration in the aeration basins and RAS (clarifier underflow).

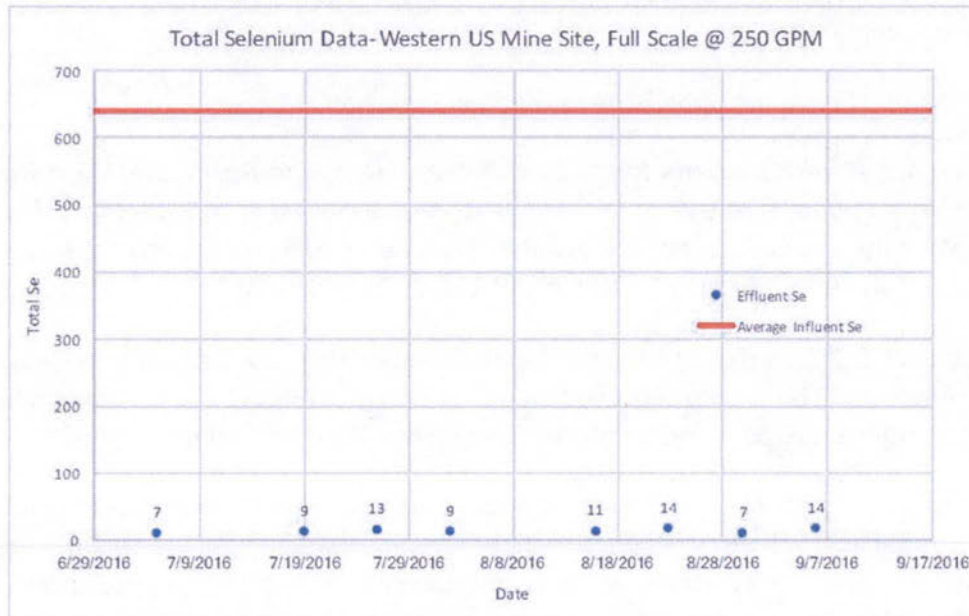
Response: Please refer to the response to SC-21. Extensive operational monitoring will be occurring at the water treatment plant; however, the scope of the reported data will be limited to the overall system performance (influent vs. effluent), for the parameters defined in Table 3-8.

EPA
SC-23 Section 3.3.2, Page 32, Pilot Unit Monitoring, Table 3-8, RO concentrate. The primary purpose of the two FBR units in the Phase 2 Pilot is to remove Se from the concentrate (or reject) stream of the RO unit. It is stated that the solutes will be concentrated by 4 times in that water. With an average influent concentration of 125 µg/l, the water to be treated in each FBR would be anticipated to have an average of 500 µg/l (and if maximum is 140 µg/l, there could be a maximum of 560 µg/l). EPA is unaware of prior studies demonstrating removal of such high concentrations within FBR systems, and thus it may not be possible to reduce levels to the water quality criterion. However, the effluent from the FBR post-treatment will be diluted by water having little to no Se (RO clean water stream) prior to being discharged at the outfall, so the final water may meet the criterion.

Sampling locations noted in Table 3-8 indicate that influent and effluent are to be sampled weekly, but that the effluent from the FBRs are going to be sampled only on week zero and at shut-down. The location of the effluent sampling is not clear, but this reviewer assumes that it is after the mixing of the water sources and prior to discharge at the outfall. It is recommended that effluent from the FBRs be sampled at a few of the weekly sampling events across the entire period of the pilot to understand the potential source of Se that was observed in the Phase I final effluent. Modifications to the design based on those findings could allow the system effluent to consistently meet WQC (and address Decision Input 2). Additionally, sampling would allow a better understanding of the actual removal attainable by the FBR system given that the Phase 2 pilot will have a much higher influent concentration than did the Phase 1 Pilot or other studies with which we are familiar.

Response: Shown below is a depiction of full-scale data from a western U.S. mine site

that utilizes the same Frontier Model unit that is being utilized at the Smoky Canyon Mine site. As shown, the FBR unit is receiving 250 gpm of influent water at concentrations over 600 $\mu\text{g/L}$ and decreasing concentrations to less than 14 $\mu\text{g/L}$.



As recommended, additional sampling locations have been added to the monitoring program under this Work Plan/SAP, as shown in revised Table 3-8.

SC-24 Section 3.3.2, Page 34, Pilot Unit Monitoring, Table 3-11. *Should BOD, TSS, and ammonia be monitored? Monitoring nitrate but not ammonia suggests that the activated sludge system will achieve complete nitrification, which may not be assured, especially during winter. It may be that influent nitrate, phosphorus, and sulfide (as well as BOD and ammonia, if they're added) are essentially negligible – if so, these could be deleted from the influent analyte list after collecting sufficient data to demonstrate that this is the case. Please clarify.*

Response: BOD, TSS, and ammonia have been added to the focused analytical suite presented in Table 3-10 (formerly Table 3-11).

SC-25 Section 3.4, Page 36, Investigation-Derived Waste Management and Demobilization, numbered list. *Items 4 and 5 refer to dewatered sludge. How will sludge dewatering be performed?*

Response: The sludge will continue to be hauled in thin state. If sludge dewatering is to be performed, a work plan modification or addendum will be submitted.

SC-26 Section 4.2, Page 37, Inputs to the Decision and Decision Rules, Decision Rule (1). *The Agencies question the use of the word "effective". Use of the word effective in this*

type of context customarily means achieving a goal, not just effecting a reduction. For instance, if 90% removal of a contaminant were required, and a system achieved a statistically significant removal of 10%, one wouldn't normally consider this effective. Please revise wording to something like "system is capable of removing...", or "...system achieved removal of..."

Response: The wording has been revised as requested.

SC-27 Section 4.2, Page 38, Inputs to the Decision and Decision Rules, Decision Rule (3).

This is very confusing as written, especially regarding the "other" parameters (other than Se). Not sure why the comparison to influent level is needed, as opposed to just comparing values to the benchmarks in Table 4-1. Please revise.

Response: Decision Rule 3 has been revised to state that characteristics of treated effluent water will be evaluated based on comparisons of effluent concentrations to water quality standards or benchmarks. The text has been revised to:

"Effluent concentrations will be compared to the water quality standards or benchmarks shown in Table 4-1. If effluent concentrations are below water quality standards or benchmarks, then the effluent is suitable to be discharged to streams that support aquatic life."

SC-28 Section 4.2, Page 39, Inputs to the Decision and Decision Rules, Table 4-1. It is appropriate to include benchmarks for other parameters, such as pH, BOD, DO, sulfide, and NH3. Also, why is the benchmark for calcium "NA" rather than "g"? Please clarify.

Response: Benchmarks, as available, have been added for these other parameters. Also, the "Selected Benchmark" entry for calcium has been defined as "No applicable benchmark" as it is a component of total dissolved solids (TDS). Additionally, Table 4-1 has been updated based on the table of benchmarks presented in the Smoky Canyon Mine RI/FS *Final Site-Specific Ecological Risk Assessment Report* (Formation 2015b), and to include additional water quality parameters and revised benchmarks based on updated literature and hardness-based values.

Additional Specific Comments (January 13, 2017):

SC-1 Section 3.0, Page 15: In the second paragraph refer to "selenium is the only primary COPC ... "

Response: Selenium is the only COPC that is called a "primary COPC" in the Smoky Canyon Mine RI/FS. Therefore, the text in Section 3.0 and also in Section 2.1 has been revised to state that "selenium is the primary COPC and it exceeds water quality criteria..."

SC-2 *Section 3.2.2: The text does not cover the criteria when the different analytical suites will be used in the monitoring but only as a note in table 3.8. Please include a short discussion on when each analytical suite will be used. Analytes in the Phase 1 full analytical suites should not be dropped from the sampling plan to Phase 2 full analytical suite unless week 0's or sequent week's results indicate below detection limits or the values are less than 50% of the chronic exposure and are stable or decreasing.*

Response: This comment appears to refer to Section 3.3.2 (there is no Section 3.2.2). Analysis of weekly samples from Weeks 0 through 12 will alternate between the full analytical suite (same as used in Phase 1) and the focused analytical suite. A reduced full analytical suite for Weeks 0 through 12 is no longer proposed in this Work Plan/SAP.

The following text has been added to Section 3.3.2, 3rd paragraph:

"During Weeks 0 through 12, environmental sampling will take place weekly with analyses each week alternating between the full analytical suite and the focused analytical suite (see Table 3-8). After receipt of the environmental monitoring results for Weeks 0 through 12, the data will be reviewed and conditions for eliminating specific analytes will be discussed with the Agencies. Environmental monitoring after Week 12 will take place bi-weekly and analyses will follow the focused analytical suite. In addition, environmental monitoring will include one sampling event each quarter, with analysis per the full analytical suite which may be revised based on review of Weeks 0 through 12 results."

SC-3 *Section 6.2.2, Page 47: As part of the SAP, please provide proof that the labs referenced are certified labs for environmental work.*

Response: Proof that the laboratories referenced in the SAP are certified for environmental work will be provided in the revised SAP in new Appendix F.

SC-4 *Appendix D (Summary of Results), Page 1, 2nd paragraph: This paragraph discusses weeks 0-12 with a reference to March 2016 to June 2016, but contains data for March 2015 to June 2016. It is understood that there were several starts and stops due to biofouling and other operational issues. A paragraph describing the operational issues should be included in this section and as to why the data from March 2015 to March 2016 are being dropped from being used in the appendix.*

Response: As requested, the following discussion has been added on Page 1 after the 2nd paragraph:

"Note that this appendix presents monitoring results from the Phase 1 study extending back to the initiation of the study in March 2015. Although most of the tables and figures include results from all of the sampling events since that time, the discussion focuses on

results of environmental monitoring for Weeks 0-12 starting in March 2016. Results prior to March 2016 are not discussed because, after the initial startup in early 2015 and continuing into early 2016, there were several starts and stops with adjustments and additions made to the system to address operational issues including the hydraulics between the aeration tank and sand filter, occurrence of the filamentous sulfide-oxidizing bacteria, and excessive bio-film buildup in tanks (addressed by nutrient dosing). Because the results from March 2015 to March 2016 do not represent a long-term operational condition, this part of the dataset was not evaluated in this appendix."

Table 3-8: Pilot Study Monitoring, Sampling, and Analysis Schedule

Week (System Status)	Sampling Frequency	Sampling Locations	Analyses to be Performed ^a
Week 0 ^b (Initial Steady State Flow After Start Up)	One-time	Influent, Effluent Blend Tank, UF Backwash UF permeate flow to RO skids; RO permeate flow to blending tank; RO concentrate flow to the FBRs; Bioreactor Effluent from FBR #1; Bioreactor Effluent from FBR #2; Sand filter #1 effluent; Sand filter #2 effluent	Full analytical suite ^c
Week 1 ^b (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 2 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 3 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 4 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 5 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 6 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 7 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 8 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 9 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 10 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 11 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 12 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Review and statistically evaluate the results from Weeks 0-12. Simplot and the Agencies will discuss refinement of the interim water quality target parameters. With justification, some of the parameters in the full analytical suite may be eliminated based on the results from Weeks 0-12 ^e . Furthermore, upon receipt of results from Weeks 0-12, Simplot will calculate expected water quality concentrations at key locations downstream of the treatment facility for discussion with the Agencies.			
Week 14 and every other week thereafter (Operational)	Bi-weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Once per quarter (quarterly sample also meets requirement for bi-weekly sample)	Quarterly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Operational – Immediately Prior to Shut Down	One-time	Same as Week 0 locations	Full suite ^c

Notes:

^a All lab turnaround times are "standard" (2 to 3 weeks).

^b "Week 0" is the period immediately after start up, "Week 1" is approximately one week after startup, etc.

^c Refer to Table 3-9 for list of analyses and methods; some parameters may be eliminated from the full analytical suite after Week 12, based on review of results. Any refinements/reductions to the full analytical suite will be implemented after approval by the Agencies.

^d Refer to Table 3-10 for list of analyses and methods.

^e Note that the evaluation will be available 4 to 6 weeks after sample collection to allow for the standard lab turnaround time of 2 to 3 weeks and subsequent evaluation.

Table 4-1: Benchmarks for Surface Water

Water Quality Parameter			USEPA National Recommended Water Quality Criteria ¹		Idaho Surface Water Quality Standards ²		Alternative Chronic Values			Surface Water Benchmark
			Freshwater CCC (Chronic) Criteria		Aquatic Life CCC (Chronic) Criteria					Hardness (mg/L) =
CAS No.	Analyte	Units	Value	Notes	Value	Notes	Value	Notes	Source	100
7429-90-5	Aluminum	mg/L	0.087	b	---	---	1.37	c	⁶ Parametrix 2009	1.37
7440-36-0	Antimony	mg/L	---	---	---	---	1.60	b	³ USPEPA 1986	1.60
7440-38-2	Arsenic, Dissolved	mg/L	0.15	a	0.15	a	---	---	---	0.15
7440-39-3	Barium	mg/L	---	---	---	---	0.44	b, c	⁴ MDEQ 2016 - FCV	0.44
7440-41-7	Beryllium	mg/L	---	---	---	---	0.007	b, c	⁴ MDEQ 2016 - FCV	0.007
7440-42-8	Boron	mg/L	---	---	---	---	7.2	b	⁴ MDEQ 2016 - FCV	7.2
7440-43-9	Cadmium, Dissolved	mg/L	0.0007	a, 9	0.00057	a	---	---	---	0.00057
184-540-299	Chromium VI, Dissolved	mg/L	0.011	---	0.011	---	---	---	---	0.011
160-658-31	Chromium III, Dissolved	mg/L	0.074	a	0.074	a	---	---	---	0.074
7440-48-4	Cobalt	mg/L	---	---	---	---	0.10	b	⁴ MDEQ 2016 - FCV	0.10
7440-50-8	Copper, Dissolved	mg/L	BLM	d	0.011	a	---	---	---	0.011
7439-89-6	Iron	mg/L	1	b	---	---	---	---	³ USPEPA 1986	1
7439-92-1	Lead, Dissolved	mg/L	0.0025	a	0.0025	a	---	---	---	0.0025
7439-96-5	Manganese, Dissolved	mg/L	---	---	---	---	1.65	c	⁵ CDPHE 2009	1.65
7439-97-6	Mercury, Dissolved	mg/L	0.00077	---	---	---	---	---	---	0.00077
7439-98-7	Molybdenum	mg/L	---	---	---	---	3.20	b	⁴ MDEQ 2016 - FCV	3.20
7440-02-0	Nickel, Dissolved	mg/L	0.052	a	0.052	a	---	---	---	0.052
7782-49-2	Selenium	mg/L	0.005	b	0.005	b	---	---	---	0.005
7440-22-4	Silver, Dissolved	mg/L	0.0032	a, e	0.0034	a, e	---	---	---	0.0034
7440-28-0	Thallium	mg/L	---	---	---	---	0.0072	b	⁴ MDEQ 2016 - FCV	0.0072
7440-61-1	Uranium, Dissolved	mg/L	---	---	---	---	1.50	c	⁵ CDPHE 2009	1.50
7440-62-2	Vanadium	mg/L	---	---	---	---	0.027	b	⁴ MDEQ 2016 - FCV	0.027

Water Quality Parameter			USEPA National Recommended Water Quality Criteria ¹		Idaho Surface Water Quality Standards ²		Alternative Chronic Values			Surface Water Benchmark
			Freshwater CCC (Chronic) Criteria		Aquatic Life CCC (Chronic) Criteria					Hardness (mg/L) =
CAS No.	Analyte	Units	Value	Notes	Value	Notes	Value	Notes	Source	100
7440-66-6	Zinc, Dissolved	mg/L	0.12	a	0.12	a	---	---	---	0.12
7440-70-2	Calcium	mg/L	---	---	---	f	---	---	---	NA
7439-95-4	Magnesium	mg/L	---	---	---	f	---	---	---	NA
7440-09-7	Potassium	mg/L	---	---	---	f	---	---	---	NA
7440-23-5	Sodium	mg/L	---	---	---	f	---	---	---	NA
---	Alkalinity, as CaCO3	mg/L	---	---	---	f	---	---	---	NA
140661-28-5	Chloride	mg/L	230	3	---	f	317	n	⁷ Iowa DNR 2009	317
18785-72-3	Sulfate	mg/L	230	3	---	f	1,093	o	⁷ Iowa DNR 2009	1,093
7664-41-7	Ammonia as N	mg/L	calculate	g	calculate	g	---	---	---	calculate
---	Biochemical Oxygen Demand	mg/L	---	---	narrative	h	---	---	---	NA
---	Dissolved Oxygen	mg/L	>6	i	>6	i	---	---	---	>6
---	Nitrate + Nitrite as N	mg/L	---	---	---	---	---	---	---	NA
---	pH	NA	6.5-9	j	6.5-9	j	---	---	---	6.5-9
---	Sulfide	mg/L	2	k	---	---	---	---	---	2
---	TDS	mg/L	---	---	---	---	1,134	l	⁸ Chapman et al. 2000	1,134
---	TSS	mg/L	---	---	narrative	m	---	---	---	NA

Table 4-1 Notes

This table is updated from Table 2-9 of the Final Site-Specific Ecological Risk Assessment Report (Formation 2015b), and includes additional water quality parameters and updates to benchmarks based on updated literature and hardness-based values. While hardness is set at 100 mg/L for this table, the actual ambient hardness of the water to be evaluated will be used for calculation of the benchmark.

Only the basis upon which the benchmark is based is presented here, with data evaluated using the appropriate basis (dissolved vs. total).

When Idaho State Standards were available, they were used as the benchmark even if they were not the most conservative benchmark. Similarly, literature-based values are used for benchmarks, instead of older National Recommended Water Quality Criteria, if the values are more recent and from ecotoxicological studies.

"---" = Information not applicable or not available

CAS – Chemical Abstracts Service

"NA" = No applicable benchmark

CCC - Criterion Continuous Concentration (i.e., chronic)

mg/L - milligram per liter

^a Aquatic life criteria for these metals are expressed as a function of total hardness (mg/L as calcium carbonate), the pollutant's water effect ratio (WER) and multiplied by an appropriate dissolved conversion factor. For comparative purposes only, the values displayed in this table are shown as dissolved metal and correspond to a total hardness of one hundred (100) mg/L and a water effect ratio of one (1.0). Criteria values for other hardness may be calculated from the following: CCC (dissolved) = $\exp \{mC[\ln(\text{hardness})] + bC\}$ (CF).

^b Criterion is expressed as total or total recoverable (unfiltered) concentration.

^c Hardness-based value calculated using 100 mg/L CaCO₃.

^d The current copper criteria are based on the Biotic Ligand model (BLM) and requires site specific data inputs to derive the criterion value.

^e Silver criteria is acute value, chronic value not available

^f No aquatic life criteria available, but considered as a component in total dissolved solids (TDS)

^g Calculated as a pH and temperature dependent value - see Table A (below) for values when early life stage fish are present and not present.

^h Oxygen-Demanding Materials. Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition. IDAPA 58.01.02

ⁱ Dissolved oxygen is a minimum value.

^j pH to fall within the applicable range to be acceptable.

^k Expressed as H₂S.

^l No observed effects level of chironomids.

^m Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities.

ⁿ Derived based on hardness and sulfate concentrations (assumed sulfate = 40 mg/l).

^o Derived based on hardness and chloride concentrations (assumed chloride = 100 mg/L).

Table 4-1 Criteria Sources

¹ U.S. Environmental Protection Agency (EPA). 2009a. National Recommended Water Quality Criteria (NRWQC) for Priority Pollutants. EPA Office of Water, Office of Science and Technology (4304T). Available at <http://www.epa.gov/waterscience/criteria/wqcriteria.html>. Updated December 2, 2009.

² Idaho Administrative Procedures Act (IDAPA) 58.01.02 water quality standards - IDAPA Numeric Criteria for Toxic Substances for Waters Designated for Aquatic Life, Recreation, or Domestic Water Supply Use (IDAPA 2016).

³ U.S. Environmental Protection Agency (EPA). 1986. Quality Criteria for Water 1986 ("The Gold Book"). EPA 440/5-86-001. May 1, 1986.

⁴ Michigan Department of Environmental Quality (MDEQ). 2016. Freshwater Chronic Values (FCV) from Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4. Water Quality Standards gives procedures for calculating water quality values to protect humans, wildlife and aquatic life. Updated 10/21/2016.

⁵ Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Commission (WQCC). 2007. Reg. Number 32. Classifications and Numeric Standards for the Arkansas River System, updated February 2009. Available at <http://www.cdphe.state.co.us/regulations/wqccregs/100232arkansasriverbasinnew.pdf>

Table 4-1 Criteria Sources (continued)

⁶ Parametrix. 2009. Updated Freshwater Aquatic Life Criteria for Aluminum (Exhibit 2 of Direct Testimony of Robert W. Gensemer, Ph.D.). Prepared for Los Alamos National Laboratory. 25 pp.

⁷ Iowa DNR. 2009. Water quality standards review: Chloride, sulfate, and total dissolved solids. Iowa Department of Natural Resources, Des Moines, Iowa. http://www.iowadnr.gov/portals/dnr/uploads/water/standards/ws_review.pdf

⁸ Chapman, P.M., H. Bailey, and E. Canaria. 2000. Toxicity of Total Dissolved Solids Associated with Two Mine Effluents to Chironomid Larvae and Early Lifestages of Rainbow Trout. Environmental Toxicology and Chemistry: Vol. 19, No. 1, pp. 210–214.

⁹ USEPA. 2016. Aquatic Life Ambient Water Quality Criteria, Cadmium - 2016. EPA-820-R-16-002. <https://www.epa.gov/wqc/aquatic-life-criteria-cadmium-documents>

Table A. Chronic Criterion Calculation for Ammonia When Early Life Stage (ELS) Fish are Absent or Present

Temp (degrees C)	pH	Total Ammonia N (mg/L)	
		ELS Absent	ELS Present
9	6.5	9.51	6.67
10	6.5	8.92	6.67
11	6.5	8.36	6.67
12	6.5	7.84	6.67
13	6.5	7.35	6.67
9	7	8.43	5.91
10	7	7.91	5.91
11	7	7.41	5.91
12	7	6.95	5.91
13	7	6.52	5.91
9	7.5	6.23	4.36
10	7.5	5.84	4.36
11	7.5	5.48	4.36
12	7.5	5.13	4.36
13	7.5	4.81	4.36
9	8	3.47	2.43
10	8	3.26	2.43
11	8	3.05	2.43
12	8	2.86	2.43
13	8	2.68	2.43